Prepared by
Robert M. Linn (NPS)
6/29/64

a good

VEGETATION TYPES

1. The [illegible] Forests of Great Smoky Mountains National Park are the largest spruce-fir, 'Boreal' forest stand in the eastern [illegible]

2. The Spruce-fir is here distinct--being composed of [illegible] fir--the largest forest of these species anywhere in the world. [?]

3. The "Boreal" Spruce-fir forest of eastern North America [illegible] southmost limit in Great Smoky Mountains National Park and [illegible] Ridge Parkway for reasons not entirely known, but postulated [illegible] of post-glacial climatic changes.

4. Since spruce-fir reaches it southernmost limit here, [illegible] or retraction in the range of the type over a number of years [illegible] in determining and/or plotting subtle climatic changes.

5. Since there are burned-over and cut-over areas of spruce-fir [illegible] Smoky Mountains National Park, successional changes and progress [illegible] and results made available to the scientific and forestry fields [illegible]

THE GRASSY BALDS

1. If the grass balds are natural, as most investigators believe, [illegible] one of the few (if not the only) areas where they may continue to be [illegible] studied unaltered by man.

2. The balds [illegible] a phenomenon fairly unique to the southern [illegible]

3. Balds often [illegible] habitat of the surrounding mountains [illegible]

1. The Cove Hardwood forests have provided species which migrated to all sections of the Eastern Deciduous Forest after the glacial age.

2. The Cove Hardwoods contain many record and near-record size individuals --denoting superior habitat for the individual in question and longevity of pristineness.

3. Aesthetically the Cove Hardwoods have the stateliness and other intangible qualities that denote "the forest" to most persons viewing them.

4. The Cove Hardwoods contain a huge number of different tree, shrub, herb and fern species.

THE HEMLOCK FORESTS

Hemlock occurs only in rare, sheltered ravines in the southeastern States; northward it occurs much more abundantly, being one of the major constituents of the Northern Hardwood Forest Association. The southern Appalachian hemlock sites are among the best, however, and should be protected,especially since no major protection is offered this species in any other National Park except Great Smokies and Shenandoah.

THE OAK AND PINE FORESTS

1. The Oak and Pine forests have scientific values for studies of succession in logged areas and studies of eventual composition in former Oak-Chestnut stands in both logged and pristine areas.

2. The former Oak-Chestnut forests are preserved only in Great Smoky Mountains and in Shenandoah in the National Park System.

3. The more open stands of Oak and Pine on the drier ridges contain spectacular displays of Kalmia latifolia (Mountain Laurel) and other flowering heaths.

THE HEATH BALDS

The value of the Heath Balds is their beauty when the shrubs are in bloom.

THE NORTHERN HARDWOOD FORESTS

The southern Appalachians offer the southernmost area in which the Northern Hardwood Forest can survive. These trees reach to nearly their altitudinal limits in the Great Smokies, with characteristic stunted-twisted growth. The transition between these Northern Hardwoods and spruce-fir is a "zone of tension" which may fluctuate up or down depending upon minor climatic fluctuations. This is a valuable ecological study resource which has not been fully pursued.

THE BEARS

The Black Bear is one of the major attractions along the roadside in the Smokies. This is due to the habit acquired by some bears of begging for handouts and raiding trashcans along the highways. In spite of the unnatural conditions involved, the bears remain as a major value to wildlife appreciation on the part of the public.

THE AQUATIC LIFE

The values of aquatic habitats in the Great Smokies are: recreational fishing; aesthetic sights and sounds; one of the few remaining "clear-stream" areas of the Eastern United States; many varied habitats for at least 72 species of fish; one of the few remaining places where native Appalachian strains of Brook Trout are found; one of the few remaining areas of Eastern United States where species differentiation in adjacent watersheds may be studied with little or no human influence factors.

THE ECOSYSTEMS

The forests of the Great Smokies exist where they do in response to climatic, geologic, soil and topographic conditions; the lesser plants and the animals exist where they do in response to the physical factors mentioned plus the forest dominants. The forests lay the pattern for the remainder of the wildlife; the wildlife species will prosper as their habitats prosper, and suffer as their habitats suffer, and change as their habitats change.

REPORT

An Evaluation of the Natural Resources and Values, and A Delineation of Resources and Values to be Preserved, in Great Smoky Mountains National Park, North Carolina and Tennessee.

PROLOGUE

Natural Resources and values fall into several categories: some are material objects or conditions and easily defined, some are conceptual or abstract and not so easily defined. These Resources, further, are of varying value to the different segments of the American population with their varied interests and desires. The attempt here has been to define the values, to describe their meaning, and to evaluate them as to their significance.

The outstanding resource of Great Smoky Mountains National Park is the thin, but luxuriant, veneer of vegetation which clothes nearly all of the Park. The rocks, soils and climate which support this vegetation, the animal life which is supported by, and interacts with, the vegetation and the many thin ribbons of stream life which thread their way through this vegetation are all mandatory ingredients in the resources-values spectrum. It is the variability of the soils, climate, vegetation, and animal life that breathes meaning, significance and uniqueness into the Great Smoky Mountains. The following are descriptions of the several kinds of resources and values upon which the development of the Park ought, ultimately, to hinge.

1. THE BOREAL FOREST FORMATION

Description of the Boreal Forest Formation

The main Boreal Forest formation extends from near the Bering Seacoast of Alaska eastward in a gigantic arch which swings southward through the regions of Great Bear Lake, Great Slave Lake, Lake Athabaska, Lake Winnipeg, touching the northern shore of Lake Superior and portions of the southern shores of Hudson and James Bays, thence eastward to the Atlantic coast and central Newfoundland. This is the most extensive forest type in North America. The major tree species of this main Boreal Forest are White Spruce, Balsam Fir, Black Spruce, Larch, Paper Birch and Northern White Cedar. Commonly, it is called the Spruce-fir Forest.

Spruce and fir extend southward upon the higher mountain slopes into both eastern and western United States. The western southward extensions, however, are composed of species of spruce and fir which are quite different from the main Boreal species. In the eastern United States, spruce and fir extend southward along the higher ridges and peaks of the Appalachian system. Here, too, the species change; but much more subtly and the casual observer does not readily discern the change.

From northeastern Maine southward, Red Spruce increases in importance over White Spruce until White Spruce drops out entirely south of New York State. The Appalachians in Pennsylvania are not of sufficient altitude to support spruce and fir, but the southern Appalachians extending from West Virginia into the Great Smoky Mountains and the Southern Blue Ridge, do attain

the sufficient altitude. In the southern Appalachians, the Balsam Fir of the north is replaced by Fraser Fir. The major hardwood associate of Spruce-fir in the north is Paper Birch, and in the southern Appalachians Paper Birch is absent and its place is more or less occupied by Yellow Birch.

The Southern Appalachian Spruce-Fir Forest

The Spruce-fir forest of the southern Appalachians is, therefore, composed of Red Spruce and Fraser Fir which are taxonomically distinct from their northern counterparts, but which form a distinctly look-alike, boreal-type forest. This southern Appalachian Spruce-fir forest is considered by ecologists as being a part of the Boreal Forest formation, but also as a distinct entity with species and species composition found nowhere else.

The species composition of the southern Appalachian Spruce-fir forest is as follows, given in terms of some of the more major species only, and compared with spruce-fir forest species composition as found at Isle Royale National Park:

Species in Great Smoky Mountains National Park Southern Appalachian Spruce-fir	Comparable Species in Isle Royale National Park Main Boreal Forest Spruce-fir
Fraser Fir	Balsam Fir
Red Spruce	White Spruce
Yellow Birch	Paper Birch
American Mtn. Ash	American Mtn. Ash
Fire Cherry	Fire Cherry
Bush Honeysuckle (*Diervilla sessilifolia*)	Bush Honeysuckle (*Diervilla lonicera*)
Red-berried Elder	Red-berried Elder
Canada Blackberry	---
---	Thimbleberry
Spreading Shield Fern	---
---	Bracken Fern
Yellow Clintonia	Yellow Clintonia
Bluets	---
Mountain Wood-sorrel	---
---	Canadian dogwood
---	Fringed Polygala
Mountain Aster	---
White Wood-aster	Large-leaved Aster

Lines connect species of more-or-less ecological equivalency.

The following species are distinctively southern, making the southern Appalachian spruce-fir community distinct from its northern counterpart:

Abies fraseri (Fraser fir)

Vaccinium erythrocarpum (Mountain Cranberry)

Menziesia pilosa (Minnie-bush)

Solidago glomerata (Skunk Goldenrod)

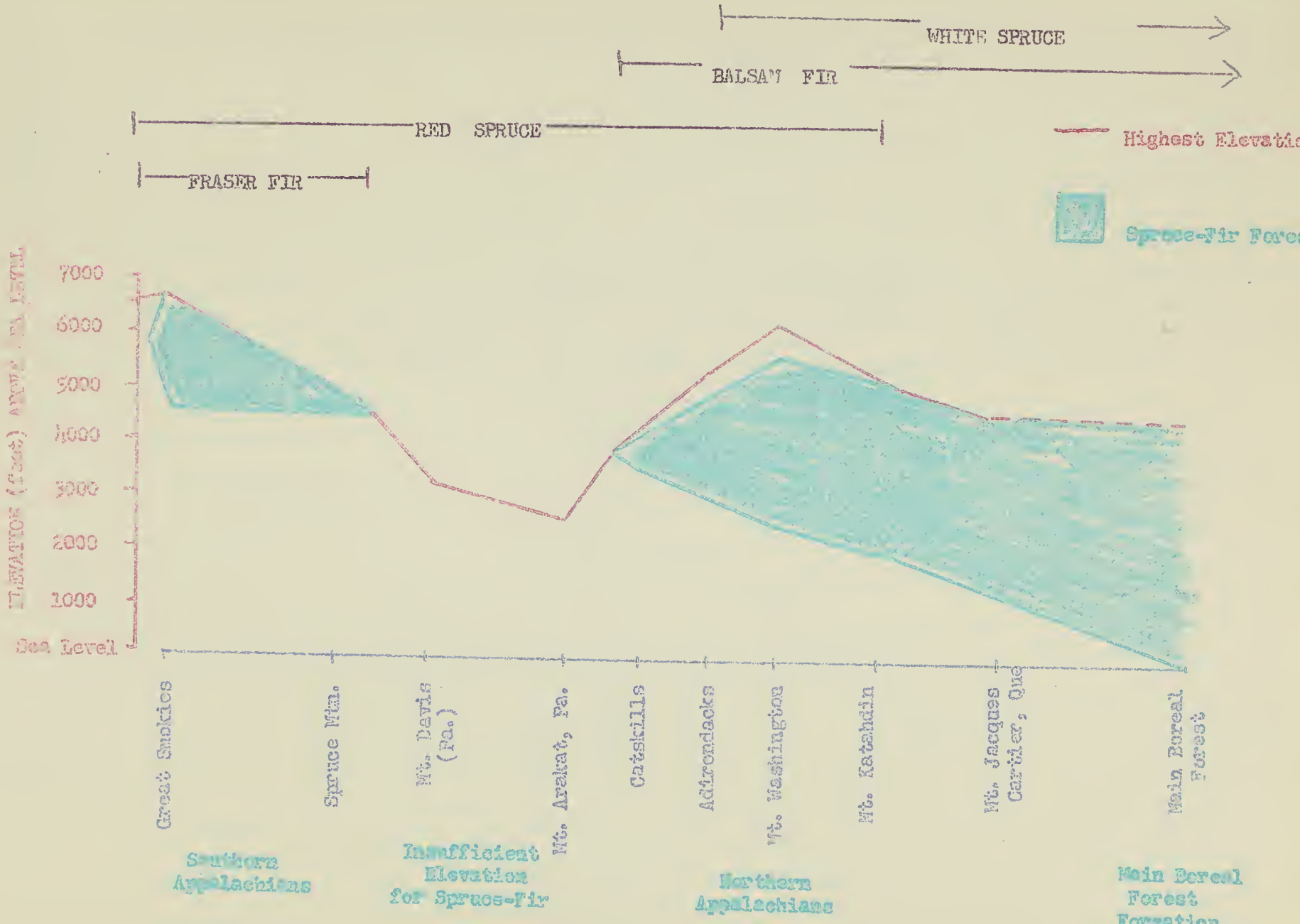
Senecio rugelia (Rugel's Ragwort)

Geum radiatum (Appalachian Avens)

Parnassia asarifolia (Grass-of-Parnassus)

Chelone lyoni (Turtle-head)


Mt. Washington
Adirondacks
Catskills
North American
Boreal Forest
Formation


WHITE SPRUCE
BALSAM FIR
RED SPRUCE
FRASER FIR
Highest Elevatio
Spruce-Fir Fore
ELEVATION (feet) ABOVE SEA LEVEL
7000
6000
5000
4000
3000
2000
1000
Sea Level
Great Smokies
Spruce Mtn.
Mt. Davis (Pa.)
Mt. Ararat, Pa.
Catskills
Adirondacks
Mt. Washington
Mt. Katahdin
Mt. Jacques Cartier, Que.
Main Boreal Forest
Southern Appalachians
Insufficient Elevation for Spruce-Fir
Northern Appalachians
Main Boreal Forest Formation

SKETCH MAP OF GREAT SMOKY MOUNTAINS NATIONAL PARK
SHOWING THE APPROXIMATE AREA OF THE
SPRUCE-FIR FOREST

Of the southern Appalachian spruce-fir areas, which may originally have been only about 1,000,000 acres in extent, the spruce-fir of Great Smoky Mountains National Park is the most extensive extant tract; and, the Great Smoky Mountains have doubtless been the major site for this forest type for thousands of years.

The southernmost limit of spruce-fir forest in eastern North America is in Great Smoky Mountains National Park just a few miles southwest from Clingmans Dome (and along the Blue Ridge Parkway south and east of GSMNP). (There have been past erroneous reports of spruce and/or fir in northern Georgia). Southwest from Clingmans Dome as one descends the Appalachian Trail from Mt. Buckley to Double Spring Gap, the last full-fledged stand of spruce-fir is left behind. (See photo).

Beyond (southwest from) Double Spring Gap is a dense stand of American Beech in which there are only occasional individuals of Red Spruce. By the time one reaches Silers Bald, about a mile southwest of Double Spring Gap, the last and southernmost Red Spruce in Great Smoky Mountains National Park has been left behind.

This southernmost terminus of Spruce and Fir is not completely understood. In the northeastern half of the Great Smoky Mountains, Spruce and Fir exist on most elevations above 4500 feet. There are numerous areas in the southwestern half of the Smokies which exceed this elevation, none of which support spruce and fir. The most reasonable explanation for this comes from Whittaker (1956):

> Of the historical interpretations which might be offered, one seems most adequate and is based on topography of the mountains. Observation of a map of the Smokies reveals a suggestive correlation: Clingmans Dome, southwest of which the last red spruce grow, is the high point of the range and the first of a series of peaks extending above 6000 ft. along the ridge to near the northeast end of the range. The spruce-fir forests grow on these high peaks and on the adjacent ridges, slopes, and valley sides down to 4500 feet. The highest points south of Clingmans Dome are Thunderhead Mountain and Silers Bald, 5530 and 5620 ft, which support deciduous forests only and, on their peaks, grassy balds. The spruce-fir forests are limited to that part of the range where peaks above 5700 ft occur.

The survival of spruce-fir forests in the area of higher peaks may be thought to have been dependent on these peaks, where the forests could find sanctuary during the xerothermic period. If, in the warm period following the last glaciation, temperatures rose sufficiently to displace the spruce-fir forests upward by 1000 ft or a little more--implying a mean temperature rise of 2° or 3° F (Shanks 1954)--their absence south of Clingmans Dome would be accounted for. A somewhat greater warming, with a displacement upward of 1300 ft, would still permit spruce to survive on summits near 6000 ft and fir and mountain ash to exist with it on northeast slopes of the peaks only a few hundred feet higher.

Of the history of high-elevation vegetation in the Smokies, it may be suggested that the spruce-fir forests extended farther south during glaciation than at present--how much farther can scarcely be guessed. During the last xerothermic period they were pushed upward to 5600-5800 ft elevation and were pushed off the tops of the lower peaks south of Clingmans Dome. As the climate cooled again, the forests advanced down the slopes from the higher northeastern peaks where they had found sanctuary and reoccupied the land above 4500 ft. Southwest of Clingmans Dome absence of spruce forests would leave mountain surfaces above 4500 ft available for those species of the eastern forests best adapted to high-elevation conditions--gray beech, northern red and white oaks, and chestnut particularly--while other deciduous species were displaced downward by the cooling climate. The spruce forests should have been moving

southwest along the ridge from Clingmans Dome in the 4000 years since the peak of the xerothermic period (Flint 1947), but are perhaps retarded or halted by the extensive beech forests of Double Spring Gap.

Values of the Spruce-Fir Forest

From this brief discussion of the "Boreal" spruce-fir forest of Great Smoky Mountains National Park, several intrinsic values may be singled-out as important and worthy of the highest kind of preservation:

1. The Spruce-fir forests of Great Smoky Mountains National Park comprise the largest Spruce-fir, "Boreal" forest stand in the southern Appalachians.

2. The Spruce-fir is here distinct from the Northern Spruce-fir--being composed of Red Spruce and Fraser Fir--the largest forest of these species anywhere in the world.

3. The "Boreal" Spruce-fir forest of eastern North America reaches its southernmost limit in Great Smoky Mountains National Park and in the adjacent Blue Ridge Parkway for reasons not entirely known, but postulated as being a result of post-glacial climatic changes.

4. Since Spruce-fir reaches its southernmost limit here, observable extension or retraction in the range of the type over a number of years could be utilized in determining and/or plotting subtle climatic changes.

5. Since there are burned-over and cut-over areas of Spruce-fir within Great Smoky Mountains National Park, successional changes and progress can be studied and results made available to the scientific and forestry fields concerned.

2. THE GRASSY BALDS

Closely associated with the high elevation spruce-fir forests of the southern Appalachians are the montane grassy balds which occur in a rather narrow altitudinal band centering at about 5400 feet elevation. To say that these balds are closely associated with spruce-fir is not quite correct, for it is more correct to say that they are associated with the absence of spruce-fir.

ORIGIN OF THE BALDS

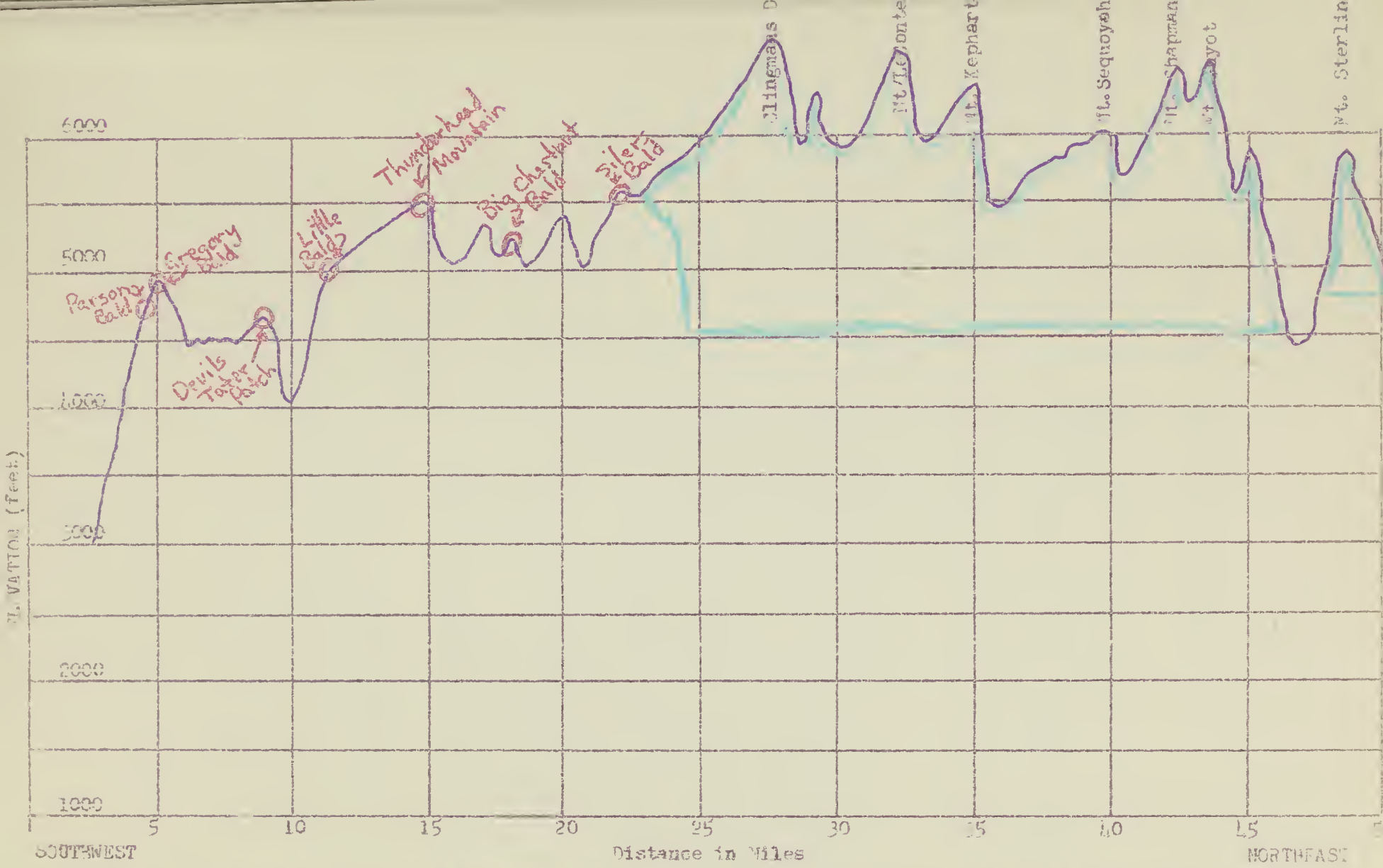
The origin of the balds occurring on some of the high peaks of the southern Appalachians has been the subject of considerable controversy. In recent years, however, enough serious scientific work has been accomplished to warrant reasonable conclusions concerning bald origin.

Following the glacial period in North America, the climate became warmer and drier over most, if not all, of the continent. This warming trend culminated in a warm-dry era (known variously as the "xerothermic," "pine maximum," and "hypsithermal") which was warmer than any other since pre-glacial times, including the present climate. During this period, spruce and fir in the southern Appalachians were "probably restricted ... to an altitude 300' to 1000' higher than its present lower limits ..." (Mark, 1958). On some of the lower peaks, spruce and fir were thus eliminated. Since this xerothermic period, climate has generally cooled, forcing the hardwood forest trees to lower elevations. Because spruce and fir were eliminated from some of the peaks, there is an absence of a seed source for these species with the consequence that where a potential spruce-fir zone now exists, only hardwoods are available and because hardwoods grow only with great "unhappiness" in this potential spruce-fir zone, a "bald susceptible" zone is formed.

Likewise, where there is a seed source for spruce and fir, a "bald susceptible" zone is likely to occur between the lower limits of spruce-fir and the upper limits of high altitude hardwoods, especially on south, southwest and west exposures. This is a zone in which neither the conifers nor the hardwoods are particularly "happy".

It is possible that some of the present balds have been treeless since post-xerothermic times. It is possible, also, that any small catastrophic event such as severe insect damage, blowdown damage, or ice damage, could have eliminated trees from "bald susceptible" areas.

Some explanation is due concerning the many more balds in the southwestern portion of the Park than in the northwest. Since the highest peaks in the Park lie in the northeastern section, and since these are the peaks that offered a refuge to the spruce and fir during the xerothermic, the prevalence of balds in the southwestern portion probably merely reflects the general absence of the spruce-fir seed source in this general area.



Location of balds (shown in red) southwest of the spruce-fir range (outlined in green shading) in Great Smoky Mountains National Park. Xerothermic warming would account for the displacement of spruce and fir from peaks lower than 5700' elevation and creation of bald susceptible zones. (After Whittaker, 1956)

MAINTENANCE, EXTENSION AND INVASION OF BALDS

That forest revegetation will establish (or reestablish) itself in the balds in time, providing no "maintenance" factor is present, has been clearly established. The establishment of Mountain Oat Grass (Danthonia compressa), forming a turf which makes it difficult for the establishment of tree and shrub species is one factor in bald maintenance. The following factors listed by Mark (1958) complete the list:

> Maintenance of the balds depends on a complex of factors which include: a. the relative severity of the open area environment at the level critical to tree seedlings. This environment would more closely approach the tolerance limits of tree seedlings than would the environment of an adjacent forest interior, b. the lack of a spruce and fir seed source from areas on which they could now potentially occur, c. possible elimination of the spruce and perhaps fir biotypes best adapted to invade downward into warmer and drier environments, and d. grazing and browsing by domestic animals in recent times, and perhaps by native herbivores prior to European settlement.
>
> Extension of balds results from: a. natural destruction of the marginal trees, especially hardwoods, exposed to relatively severe environmental conditions, b. opening up of the marginal forests by grazing animals, and c. man's extension of the grazing areas within recent times.

Tree invasion on ungrazed balds indicates that the balds at present are barely within the tolerance ranges of certain tree species and therefore may eventually become forested. Spruce and fir are invading more rapidly than hardwood. In the absence of grazing, therefore, the higher balds without a spruce and fir seed source will probably persist longer than either the lower balds or those with a spruce and fir seed source.

GRASS BALD SPECIES

By far the most abundant and important species of the grass balds is the Mountain Oat Grass (Danthonia compressa). This grass tends to form a dense mat which makes it difficult for many other plants to establish themselves. There are a number of species, however, which typically are found in the balds. Among these are the following (from Mark, 1958):

Woody Plants:

Amelanchier laevis (Serviceberry)

Crataegus macrosperma v. roanensis

Lyonia ligustrina (Lyonia)

Quercus rubra (Northern Red Oak)

Rhododendron calendulaceum (Flame Azalea)

Vaccinium vaccilans (Low-bush Blueberry)

Herbaceous Plants:

Agrostis alba (Redtop)

Angelica triquinata (filmy Angelica)

Aster surculosus (Aster)

Carex debilis v. rudgei (Drooping Wood Sedge)

Carex pensylvanica v. distans (Sedge)

Danthonia compressa (Mtn. Oat Grass)

Fragaria virginiana (Wild Strawberry)

Houstonia purpurea (Bluets)

Houstonia serpyllifolia (Bluets)

Poa pratensis (Kentucky Bluegrass)

Polytrichum commune (Polytrichum -- a moss)

Polytrichum juniperinum (Polytrichum -- a moss)

Potentilla canadensis (Cinquefoil)

Prenanthes trifoliata (Rattlesnake Root)

Prunella vulgaris v. lanceolata (Self-heal)

Rumex acetosella (Red Sorrel)

Trifolium repens (White Clover)

Viola sagittata (Violet)

Viola spp. (Violet)

Among the numerous balds in Great Smoky Mountains National Park are the following which were studies by Mark (1958, 1959).

True grass balds (of natural origin according to Mark)

Mt. Sterling Bald

High Spring Bald

Little Bald

Rocky Top Bald

Silers Bald

Thunderhead Mountain Bald

Andrews Bald

Gregory Bald

Parson Bald

Fields (not of natural origin according to Mark)

Ledge "Bald"

Russell Field

Spence Field

In spite of the wealth of literature concerning southern Appalachian grassy balds, they still present something of an enigma -- how rapidly are forest trees encroaching on the balds? Are they really "natural"? Will slight climatic fluctuations cause forest species to first encroach and then retreat? etc. The balds are, then, of value to fields of botany and ecology as an outdoor, living laboratory possessing data and knowledge yet to be determined.

Values of the Grassy Balds

1. If the balds are natural, as most investigators believe, GSMNP offers one of the few (if not the only) areas where they may continue to exist and be studied unaltered by man.

2. The balds are a phenomenon fairly unique to the southern Appalachians.

3. Balds offer unusual natural vistas of the surrounding mountainous area.

3. THE EASTERN DECIDUOUS FOREST FORMATION

The Eastern Deciduous Forest covers most of the eastern portion of the United States and adjacent southern Canada. This forest formation is extremely diverse in its species content and makeup, ranging from the open oak stands bordering the grasslands of the West, to the dense forests of the eastern bottomlands. The characteristic which holds the formation together is the deciduous nature of the trees comprising the forest.

The varied climates of the Great Smoky Mountains, due to altitudinal differences, and the varied topography with its differences in slope and exposure, combine to produce an enormity of habitats. Precipitation alone varies from about 57 inches per year at lowest elevations, to about 89 inches at the lower limit of the Spruce-fir zone, to about 91 inches at the upper limit of the Fir Forest. The average decrease in temperature with altitude is 2.23° F. per 1,000 feet of elevation. Exposure includes all of the various directions; and slope types run from concave to straight to convex. Thus, temperature, precipitation, runoff, evaporation, moisture accumulation, etc., are responsible for this wealth of habitat types.

Role of the Great Smoky Mountain in the Origin of the Eastern Deciduous Forest

Over a span of about 60 million years just previous to our current 1-million-year-long Quarternary Period, was the Period known as the Tertiary. The Earth's climate was much more even during this time, allowing a temperate type of vegetation to exist into what is now the Arctic. The Tertiary was a period of

large woody plants, and from the fossil remains many genera well known to us today have been discerned: beech, chestnut, elm, alder, birch, hazelnut, aspen, walnut, gum, sycamore, maple, oak, sequoia and ginkgo. These genera made up the Arctotertiary vegetation which spread across Greenland; northern Europe to the northern Urals; middle Asia to Manchuria, Sachalin and northern Japan; Alaska to the Pacific Northwestern United States; and in the Atlantic Northeastern United States and Canada.

By the close of the Tertiary the world climate had slowly evolved toward the glacial age known as the Pleistocene Epoch. During the Tertiary a number of inundations of the Southeastern U. S. Atlantic and Gulf coasts had taken place. But during the times of inundations and during the glacial age, the southeastern highlands remained available as a kind of refugium for plants and animals which had evolved and which were evolving. The Sequoia and Ginkgo are no longer in the flora of the southeastern highlands, but the others are still there--the same genera, evolved over the years into the present species.

In a study by Cain (1943), it was determined that 86 percent of the Cove Hardwood Tree genera, 100 percent of the Cove Hardwood shrub genera, 100 percent of the Cove Hardwood fern genera and 75 percent of the Cove Hardwood flowering herb genera are of Tertiary origin.

During the Recent Epoch (that is, that time since the retreat of the glaciers) the plant species that found refuge in the Great Smokies (and in the Cumberlands) have been able to "migrate" into the areas of Eastern United States which were previously glaciated or otherwise unavailable for terrestrial plants. The migrations for each species have been different from each other, each

migrating into environments and habitats that it could tolerate. The result is a mosaic pattern of forest associations within the Eastern Deciduous Forest (see map).

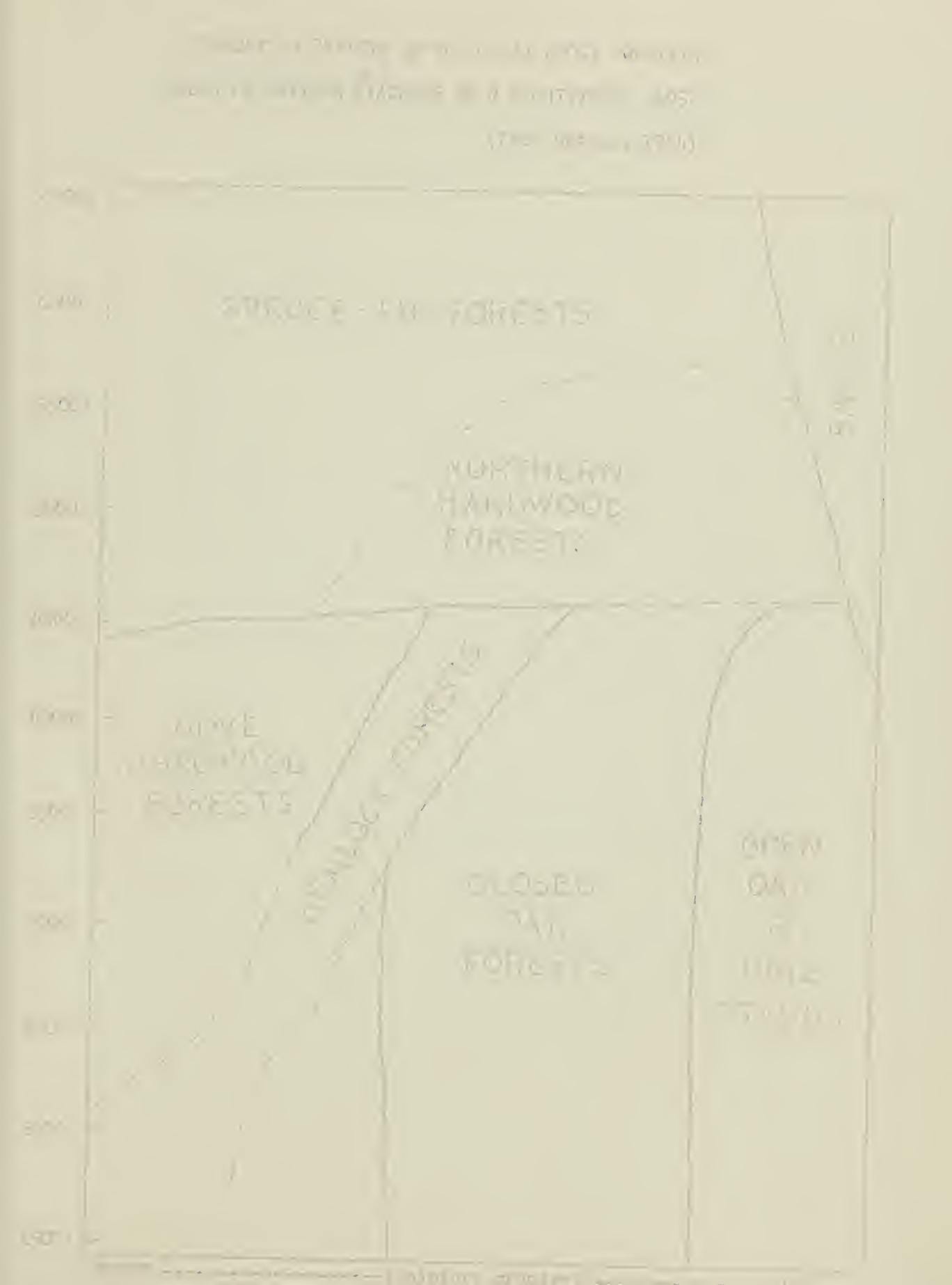
The present Cove Hardwoods in the Smokies are a general ecological equivalent of the Arctotertiary vegetation and represent (together with the "Mixed Mesophytic Forest" of the Cumberlands) the primordial root of the entire Eastern Deciduous Forest. This forest possesses, therefore, a kind of value that cannot be compared under any circumstance to the ephemeral values of political economics and the like created in the minds of men. It is rather a transcending value as "food" for the minds of men.

In the Great Smoky Mountains a similar differentiation, to produce a mosaic pattern of forest associations, has occurred along temperature and moisture gradients. Whittaker (1956) plotted this mosaic pattern on a graph which gives altitude on the vertical axis and a moisture gradient from moist to dry to the horizontal axis. The resulting graph is a convenient one to organize one's thinking on the locations of the various forest types in the Smokies.

THE EASTERN DECIDUOUS FOREST

(after Braun, 1950)

MIGRATION PATTERNS OF DECIDUOUS FOREST SPECIES
FROM THE CUMBERLANDS AND SMOKIES FOLLOWING THE
PLEISTOCENE EPOCH



a. The Cove Hardwood Forests

These forests occur below 4500' elevation in sheltered, moist, deep-soil habitats. The major tree species are:

Sugar Maple

Yellow Buckeye

Yellow Birch

Chestnut (now dead or dying due to blight)

Beech

White Ash

Silverbell

Tuliptree

Cucumber Tree

Black Cherry

Northern Red Oak

Basswood

Hemlock

(for additional species of trees and shrubs in this and the following sections, see Whittaker, 1956 and Shanks, 1954).

The following is a quotation from Stupka (1960), which is pertinent here:

"... It is largely due to the occurrence of various unspoiled stands of these cove hardwood forests, along with the stands of Canadian-zone spruce and fir at the higher elevations, that Great Smoky Mountains National Park deserves its reputation as an outstanding wilderness stronghold.

"It may be difficult for some of us to realize that the cucumber-tree grows to be greater than 18 feet in circumference, yet such a tree stands in the Greenbrier area of the Park. A yellow buckeye is almost 16 feet in circumference, a yellow birch over 14 feet, a mountain silverbell almost 12 feet, a sugar maple over 13 feet, and a yellow-poplar (Tuliptree) over 24 feet -- these are circumference measurements taken at 4½ feet from the ground. All are cove hardwood species in the park.

"Fraser magnolia, one of the many smaller trees in these forests, also reaches record proportions here; specimens are known to attain a height of over 75 feet and a trunk diameter of more than 2 feet. A number of shrubs, one of the most prevalent of which is the rosebay rhododendron, and a long list of spring-blooming herbs are to be found in the cove hardwood forests."

Values of the Cove Hardwood Forest

1. Their role in providing species which migrated to all sections of the Eastern Deciduous Forest after the glacial age.

2. They contain many record and near-record size individuals--denoting superior habitat for the individual in question and longevity of pristineness.

3. Aesthetically they have the stateliness and other intangible qualities that denote "the forest" to most persons viewing them.

4. They contain a huge number of different tree, shrub, herb and fern species.

5. They represent, essentially, the remainder of the Arctotertiary forest--the best known example in the world.

6. Many of the stands have not been altered by modern man.

b. The Hemlock Forests

These forests are usually restricted to sheltered habitats along streams below 3000' elevation and to more exposed areas on slopes and ridges up to 4500'. The dominant species is the Eastern Hemlock, and Rhododendron is often dense in the shrub layer, but the following are also often present:

Red Maple

Sugar Maple

Yellow Birch

Sweet Birch

Beech

Tuliptree

Fraser Magnolia

Northern Red Oak

Striped Maple

Silverbell

Values of the Hemlock Forests

Hemlock occurs only in rare, sheltered ravines in the southeastern states; northward it occurs much more abundantly, being one of the major constituents of the Northern Hardwood Forest Association. The southern Appalachian hemlock sites are among the best, however, and should be protected, especially

since protection is offered this species in no major park except Great Smokies and Shenandoah.

c. Oak and Pine Forests

Oaks and Pines tolerate the drier conditions of exposed slopes and ridges better than most other species in the Park. Therefore, wherever a dry site appears, oaks and pines are predominant; the drier the site is, the more open the canopy appears and the greater the abundance of pine, so that it is possible to divide Oak and Pine Forests into the "Closed Oak Forests" and the "Open Oak and Pine Stands". There is also a change in the pine species with elevation: at lowest elevations, Virginia pine is common; at middle elevations (2500'-3500') Pitch Pine is common; and at higher elevations (up to 4500') Table Mountain Pine is common. Associated with the Oaks and Pines are:

Red Maple
Sweet Birch
Pignut, Red, and Mockernut Hickories
Chestnut
Silverbell
Black Gum
Black Locust
Sourwood

The Closed Oak Forests were, for the most part, considered Oak-Chestnut Forests until such time as the Chestnut was eradicated by the Chestnut Blight.

There are still a great many sproutings from Chestnut stumps, but it is doubtful that these can continue living for many more years. The Oak Forests cover more acreage than any other forest type in the Great Smokies--particularly in the North Carolina portion owing to the abundance of drier southeast-facing slopes in that portion. Relatively little has been done in the way of scientific studies to indicate the eventual forest composition of the old Oak-Chestnut Forest (an outstanding exception is Keever, 1953). Since much of the former Oak-Chestnut Forest in the Smokies has been logged, but with still considerable unlogged area remaining, the area presents a unique laboratory for the study of the eventual forest composition of the former Oak-Chestnut Association.

Values of the Oak and Pine Forests

1. Scientific value for studies of succession in logged areas and studies of eventual composition in former Oak-Chestnut stands in both logged and pristine areas.

2. The former Oak-Chestnut Forests are preserved only in Great Smoky Mountains National Park and in Shenandoah National Park.

3. The more open stands on the drier ridges contain spectacular displays of Kalmia latifolia (Mountain Laurel) and other flowering heaths.

d. Heath Balds (Slicks)

The shrubs of the Heath family, especially Kalmia, form a more or less continuous shrub layer in the Open Oak-Pine Forests. Since these forests are driest and usually in excellent position for lightning fires to get started,

the forest tree canopy is occasionally destroyed leaving the heaths in command. The heaths also can occupy sites which have been subject to landslides. The value of these Heath Balds is their beauty when the shrubs are in bloom. Since they normally occur on steep slopes and ridges which are not suited for roads or buildings, there seems little concern for their perpetuation.

e. Northern Hardwood Forests

These are high elevation forests, normally above 4500' in the "spruce-fir zone." Beech and Yellow Birch are the dominant species, but the following may also be found:

Red and Sugar Maples

Yellow Buckeye

Serviceberry

Fraser Magnolia

Black and Fire Cherry

Hemlock

+ some spruce-fir, particularly Red Spruce.

The Northern Hardwoods, while often adjacent to the Spruce-Fir Forests of the northeastern section of the Smokies, is best developed in the southwestern section beyond the range of Spruce-Fir. Here, where a spruce-fir altitudinal zone exists without a spruce or fir seed source, the Northern Hardwoods are able to survive because of the lack of competition from the Spruce and Fir. This is also the area in which "bald-susceptible"zones occur and the hardwoods normally abut the balds in stunted form.

Values of the Northern Hardwood Forests

1. The southern Appalachians offer the southernmost area in which this forest type can survive.

2. These trees reach to nearly their altitudinal limits in the Great Smokies, with characteristic stunted-twisted growth. The transition between these Northern Hardwoods and Spruce-Fir (or grass balds, if Spruce-fir is absent) is a "zone of tension" which may fluctuate up or down depending upon minor climatic fluctuations. This is a valuable ecological study resource which has not been fully pursued.

In summary to the discussion of the forests of Great Smoky Mountains National Park, it can be stated that these forests exist where they do in response to climatic, geologic, soil and topographic conditions; that the lesser plants and the animals exist where they do in response to the physical factors mentioned plus the forest dominants. The forests, then, lay the pattern for the remainder of the wildlife. The wildlife species will prosper as their habitats prosper, and suffer as their habitats suffer, and change as their habitats change.

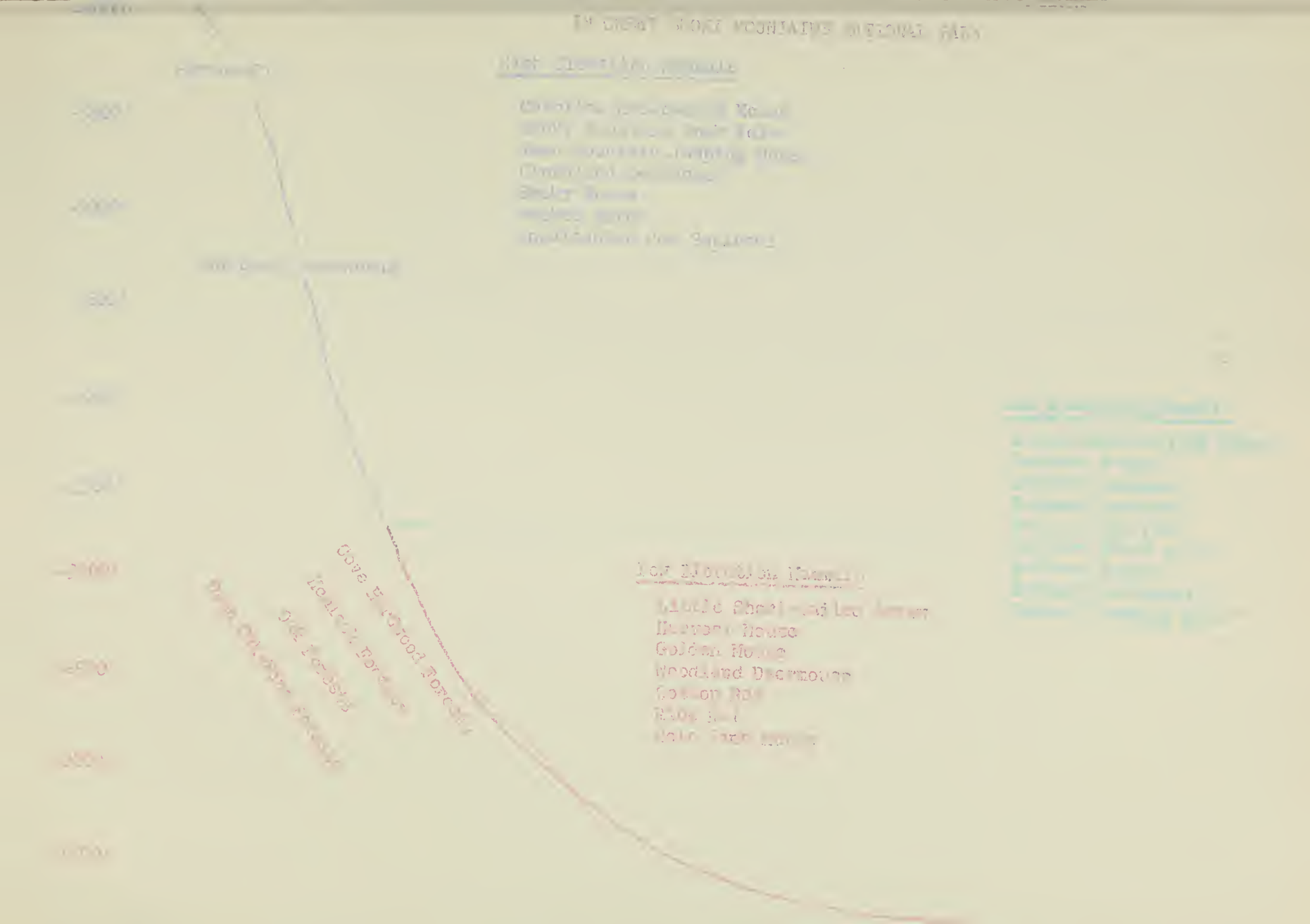
For a detailed map of the vegetation of the Park, reference is made to the Forest Type Map produced in the 1930's. This map is sufficiently accurate to be of great value in planning purposes. It is also sufficiently detailed so as to defy reproduction in this report.

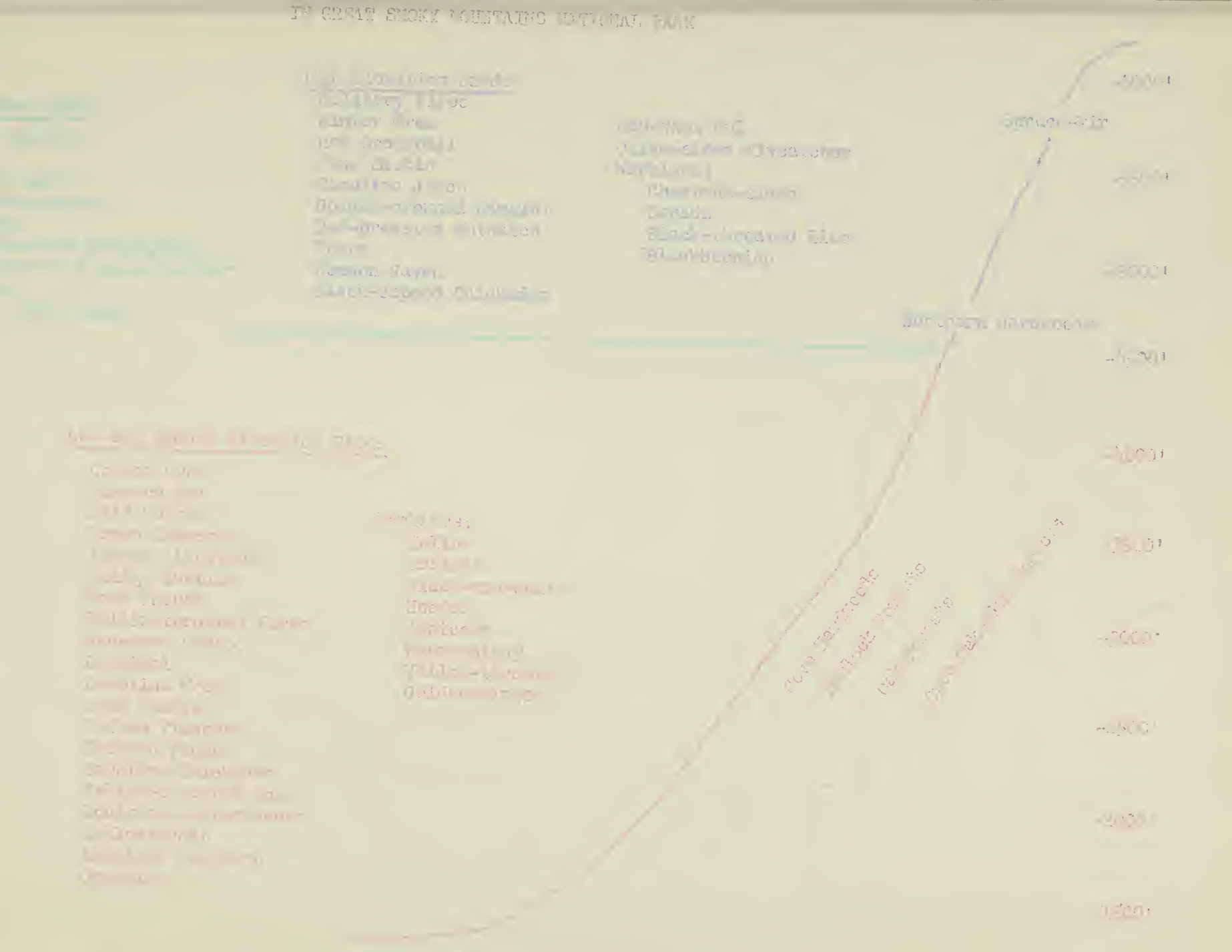
MAMMALS AND BIRDS OF GREAT SMOKY MOUNTAINS NATIONAL PARK

Each animal lives its own way in its own habitat or set of environmental conditions. These conditions are the physical factors of environment--temperature, soil conditions to some extent, moisture availability; and food factors--plants or other animals as the case may be. It is not too surprising then that animals in the Great Smoky Mountains arrange themselves into habitats corresponding to elevation and vegetation type. Some of the more common mammals and birds have been arranged on the next two pages to show this relationship.

The mammal best known to visitors at Great Smoky Mountains National Park is the Black Bear. The reason this creature is so well known is that it frequents park roadsides where it raids trashcans and "begs" for handouts. While in the Park in June 1964, this reporter counted 15 bears on a round-trip between Gatlinburg and Newfound Gap. During the same visit, however, when about 50 miles were covered by foot along Park trails, not one bear was seen. In spite of the unnatural conditions which lead to the sighting of bears by the public, and in spite of the usually completely erroneous impression visitors have about bears ("Goldilocks" type stories), the bears remain as a major value to wildlife appreciation on the part of the public.

Deer is another large mammal occasionally seen in the Park--especially in the Cades Cove area. Deer find food in greatest abundance in those areas which have been cultivated. There are almost no deer in the mature forest where their preferred browse species are lacking or nearly so. Deer, therefore, are of no major important except in the limited field or field-edge habitats.





As will be noted in the chart showing mammal distribution in the Great Smokies, the largest mammals are those which are found at most all elevations. But few of these could be considered plentiful since mature or nearly-mature forests are not conducive to high large-mammal populations.

Birds are more easily seen and heard than the mammals. There are over 200 species of birds listed for the Park, and although many of these are not commonly encountered, a person interested in birds can have an enthralling adventure in the Smokies. Again because of the varied topography, elevations and vegetation types, the serious birder can have quite an ecological-educational experience on a trip that passes through a number of elevations.

AQUATIC HABITATS

Threading their way from the cool, rainy mountaintops, through the forests, into the valleys below are 333 streams of varying volume and length. These streams, too, vary in their physical characteristics: coolest at high elevations; attaining higher temperatures when streamflow is slower or if streamflow is through areas of denuded forest; etc.

The streams offer various values to various people. This reporter has seen people simply sitting along a bank staring into a pool or the turbulent waters of a rapids; who's to know the value of thoughts-in-genesis. Others have been known to actually emplant themselves on a campstool in the midst of a flowing stream, just to cool off. Still others, perhaps the majority, find their escape or adventure in angling. These are all human values which a stream provides.

Significance of the Fish Fauna

(The following is a direct quotation from Wallis, 1959)

> "The native fish fauna of Great Smoky Mountains National Park is of national significance and importance. It should be considered as one of the outstanding biological features of the Park.
>
> "This fish fauna, consisting of over 72 forms, contains a larger number of kinds of fresh water fishes than is to be found in any other National Park Service area. The Park waters are the type localities for several "new" fishes. The distribution of the fishes and the variations which occur in these forms from each side of the mountain make the total fish fauna unique.

"The headwaters of the streams of the Great Smoky Mountains constitute some of the few remaining haunts of the native Appalachian strains of eastern brook trout.

"Although a few species are prized by the angler, the non-sport forms are important members of the native fauna. Many of these forms are so very colorful they are called "warblers of the water world." The life histories of some forms are as unique as they are fascinating.

"Because of their significance to recreation and as part of the biological heritage of the Great Smoky Mountains National Park, the fishes require adequate interpretation, management and preservation."

Studies in the past have shown that during the time of timber cutting in the Great Smokies, water temperatures rose sufficiently to permit Rainbow Trout (introduced species) to migrate further upstream. Since the return of the forest canopy over most of the once-cut area, water temperatures have returned to normal--as has the previous range of the brook trout.

Streams of the Smokies provide recreational angling values as part of the overall park experience. Among the most common sport fish are Rainbow Trout, (introduced), Brook Trout (native), Smallmouth Bass (native), Rock Bass (native), and Brown Trout (introduced).

Values of Aquatic Habitats

1. Recreational fishing as part of overall park experience.
2. Aesthetic sights and sounds.
3. One of the few remaining "clear-stream" areas of the Eastern United States.
4. Many varied habitats for at least 72 species of fish.
5. One of the few remaining places where native Appalachian strains of Brook Trout are found.
6. One of the few remaining areas of E stern United States where species differentiation in adjacent watersheds may be studied with little or no human influence factors.

Robert M. Linn
June 29, 1964

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